

A Work Project, presented as part of the requirements for the Award of a Master Degree in Economics from the NOVA School of Business and Economics.

THE EFFECT OF COMPLEMENTARITY ON REMEDIES FOR THE ANDROID CASE

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A PROJECT CARRIED OUT ON THE MASTER IN ECONOMICS PROGRAM UNDER THE
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JANUARY 4, 2019

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Abstract

The tie between Google Search and the Play Store imposed on the contracts to Original Equipment Manufacturers is only harmful to total surplus if the additional utility that smartphone users derive from the complementarity of using Google Search and Google Suite together is lower than the higher valuation of the Entrant search engine. Notwithstanding, the European Commission should take into consideration that under the previous condition, after the prohibition of tying, Google cannot exclude the Entrant anymore, but it gets higher profits than tying. Additionally, multi-homing on smartphones' search bars should be avoided as it harms further the users.

Keywords: Android, complementarity, dominance, Google, tying.

I Introduction

The Android case relates to the investigation of the anticompetitive practices Google undertook to maintain its dominant position in the general internet search services market. The firm took advantage of its dominance in the market for digital stores of smartphone applications, imposing the producers of smartphones to preinstall Google Search in the licensing agreements of the Play Store and Google applications for Android devices. With such restriction, Google was leveraging the dominance of the Play Store to achieve an unfair advantage in the more competitive market for mobile search (Cornière and Taylor, 2018).

Until April 2015, there was little evidence of what was indeed happening with Android Licensing. In order to have a Normal Android, one with access to Google Mobile Services (GMS) including the Play Store, Original Equipment Manufacturers (OEMs) needed to agree upon the "Mobile Application Distribution Agreement (MADA) and the "Anti-Fragmentation Agreement" (AFA). In short, the MADA established the tie with three requirements: the pre-installation of the GMS suite, its display in a prominent position and Google Search as the default option. On top, the AFA prohibited the OEMs from developing smartphones with other setups called forks, i.e. modifications without GMS or Google Search, under the risk of terminating all existing agreements, thus incapacitating the OEM of producing Normal Android smartphones again.

The Play Store is by far the richest application store for Android devices, and it is an essential element for the tie. Being separated from it is an enormous disadvantage for an OEM, since there will be less app development with less value delivered to users (Oxera, 2018). Furthermore, the AFA impedes the launch of other alternatives by OEMs that are already established in the market, thus increasing the barriers to entry. The "Revenue Sharing Agreement" (RSA) is offered only to some OEMs, giving them the chance to receive a percentage of ads revenues from Google Search, under the condition no other search engine is pre-installed in the smartphone.

The three most prominent players in the Search Engine Market, i.e. Google Search, Yahoo and

Bing (StatCounter GlobalStats, 2018), all belong to firms that have various other services that complement each other. From those, Google, that has a market share of over 90% in smartphones, is the foremost player in integrating other services to improve the search experience. Henceforth, I analyze how integrating different applications (apps) with the Search Engine (SE) gives Google the ability to maintain its dominant position in the Search Market. In fact, Google Mobile Services (GMS) are described as a "(...) collection of Google applications (...) that help support functionality across devices. These apps work together seamlessly to ensure your device provides a great user experience right out of the box" (Google, 2018). Relevant to this case, applications such as Google Maps and Google Translator are used to improve Google Search experience, being the results presented in a more user-friendly way than competitors.

I will focus on the smartphone market. Pre-installation and default options seem to be more determinant in excluding substitute apps in mobile devices due to the limited size of the screen. Inside this scope, I assess the relationship between Search Engines bids for pre-installation in devices, OEMs that assemble the smartphone, users and, finally, advertisers, from which SE's revenues come from. OEMs decide on the hardware, operating system (OS), search engine and the suite of apps. Notwithstanding, the components of interest here lie in the search engine and the suite (GMS or a suite unrelated to the SE), all the rest is assumed the same. To this extent, I present a model to determine how Google uses the apps inside the GMS suite, that dominate the market they are in, to foreclose other SE through tying. These apps are complements of Google Search and give an extra utility to users if used together. Additionally, the model explores remedies after the prohibition of the tying, namely, pricing of the suite taking into account complementarity across services and the effects after ruling out pre-installation and imposing multi-homing in the search engine choice. The aim is to give insights to the negotiations between the European Commission and Google testing solutions that might be desirable after the prohibition of that tying Google Search to the Play Store.

The restrictions imposed to OEM by Google were analyzed by the European Commission who

reached a decision on July 18, 2018. Google was fined 4.34 billion dollars for abusing its dominant position. In the view of the European Commission, the Play Store and Google Mobile Services were shielding Google Search from the competition (Union, 2018). Similar tying and exclusion strategies have been reported previously (Courtney, 2014). Some examples are the Google+ tie to Youtube, which did not affect Google+ penetration in the market (Bosnjak, 2018), and the Google Shopping case. However, Google continuously integrates its apps and advocates for their joint use. A recent announcement on September 24, confirmed Google will continue to follow the same path (Bohn, 2018). Whether integration builds bridges or barriers is an ongoing debate that will not be subject to consideration into my analysis.

To the extent of my knowledge, previous literature has not taken into account the complementarity between Google Search and other Google apps on the prohibition of the tie. Even now, after the European Commission's decision, I believe the dominance of Google can be maintained through the complementarity added value, especially when differences in SE's valuation are not significant for consumers as Jansen, Zhang, and Schultz (2009) empirical paper suggests. If so, the discussion on the negotiations and their effects need to be clarified. Thus, I derive the condition that endows Google with the ability to charge a license fee for certain apps' pre-installation. This payment requested to Original Equipment Manufacturers (OEM) is the recently announced arrangement Google proposed to monetize the Android Operating System (Chirgwin, 2018). Moreover, the paradigm in the search engine market would change if multi-homing was applied as a remedy, i.e. pre-installation is not determinant and users choose the SE when they want to search. I see this last remedy feasible by enabling users to choose the search engine they want when they switch on the device for the first time or by permitting search in various search engines through the same input, the same way the system notifications are a common hub and allow multi-homing for the different messaging apps (Oxera, 2018).

This paper provides answers to the questions: is complementarity between Google Search and other Google services sufficient to foreclose competition? Can a license fee foreclose an Entrant

in a no-tying scenario? What changes if multi-homing occurs in the search engine choice?

This paper is organized as follows. In section II, I describe the relevant literature that motivated this paper. Section III presents the model with separate subdivisions for the framework's description, the initial state with tying and the comparison to the social optimum in section III.A, the prohibition of tying in section III.B and remedies in sections III.C and III.D. Finally, I summarize the conclusions in section IV.

II Literature Review

Google has developed a diverse range of products whose success is deemed to innovation and simplicity of usage. All the different products, however, did not diversify Google's Revenue Structure as one would expect (Statista, 2018), but created an ecosystem for advertisements managed by Google to thrive. Following Amelio and Jullien (2012), tying is to some extent beneficial as it increases value for consumers by increasing participation or by decreasing incompatibilities and improving interface usage. Nevertheless, the literature has been focusing on the harm precluded by the "Leverage Theory of Tying". This practice bundles goods or services of different markets and, in consequence, a dominant product in a market maintains the dominance of the other product in the other separate market as Edelman (2014) argue. The tying arises anti-trust concerns (Edelman and Geradin, 2016), but what to say about Google Search increasingly integration of those apps in its results?

This paper focuses on the complementarity effect of such integration. Choi and Jeon (2018) considers markets constrained to set non-negative prices on the consumers' side that tie complements or independent goods. Furthermore, Etro and Caffarra (2017) apply and develop a similar model specifically concerning the Android case, from which the model in this paper will be based on, that verifies tying is profitable for Google and decreases consumer welfare.

The mechanism by which tying forecloses competition may be due to the fact that demand shifts in favor of one player making prospects of entry less certain (Choi and Stefanadis, 2001). This explanation alone can be an argument for Bing to keep lagging behind and no competitor has search/advertisement as core business. On the other hand, one can also consider that tying softens competition, since OEMs are induced in a bigger decision for all their devices (decision on the OS, Play Store and Apps) and cannot change their decision for other models (due to the "Anti-Fragmentation Agreement"). So, the second concern is the defense against a divide-and-conquer strategy that would consist in entrant Search Engines pay to be pre-installed in low-end smartphones from known OEMs to fight gradually for a more significant market share.

Henceforth, the literature can be summarized in two constraints Google imposes to the manufacturers' side. It restricts OEMs options, reduces secondary revenue sources and limits their potential of differentiation by bundling the Play Store, GPS and Google Search into a "Normal Android" package through the "Mobile Application Distribution Agreement" (MADA) (Edelman and Geradin, 2016). Furthermore, prohibits companies that produce Normal Androids to develop Fork Androids, which should be allowed due to Android's Open Source model, through an "Anti-Fragmentation Agreement" (AFA). Under Edelman and Geradin (2016), Google creates an "All-or-nothing" choice, instead of enabling independent smaller decisions between compatible products in different markets.

Carrillo and Tan (2015) study a model of competition among platforms with complementary products. They derive a pricing scheme and conclude platforms will prefer to maintain the exclusivity of complements. Nothing more has been said about the positive complementarity effect in utility by using the Google Suite with Google Search. Following the decision of the European Commission (Union, 2018), I will break both conditions mentioned in the previous paragraph, but considering a positive effect in Google Search value to users due to complementarity with Google Suite. Additionally, a remedy concerning multi-homing might be desirable to avoid the "deference to the default" theory (Edelman and Geradin, 2016).

III Framework

In the context of the Google Android case, I will consider five different agents. First, two competing firms, Google with Google Search and Google Suite and the Entrant with its own search engine only. Both compete in the same platform, Android, for pre-installation of the SE in devices made by OEMs. The fourth group of agents are the advertisers and, at last, a homogeneous group of users that value devices in the same manner. Following Etro and Caffarra (2017), OEMs assemble a smartphone deciding on two components: the search engine and the suite. Hardware and OS are left constant.

There are four types of devices that can be built, depending on whether the SE is Google's or the Entrant's and if Google Suite is on the device or not: (A) Entrant + no suite; (B) Entrant + suite; (C) Google + no suite; (D) Google + suite. First, I will describe a *status quo* scenario in which tying is enforced. In this scenario, only types (A) and (D) are available in the market. Afterward, the model will evaluate the remedies under the prohibition of tying. Thus all types are available.

The key parameter in the model is the complementarity effect that will only impact users' utility function when both Google Search and suite are present in the smartphone. Any complementarity between the Entrant and the mix of apps equivalent to the suite is ruled out. Also, I rule out any complementarity between Google Suite and the Entrant which is, in fact, in line with Carrillo and Tan (2015) who conclude that complements will be exclusive to each platform, in this case, each SE. Nevertheless, I assume the Entrant has a higher valuation to consumers than Google disregarding the suite as in Etro and Caffarra (2017), in order to verify whether as-least-as-efficient entry is possible.

The search engines compete for pre-installation in the devices assembled by the OEMs. They make bids and are constrained by the payment they receive from advertisers. The OEM then chooses the SE that would enable them to win the users. The users maximize surplus.

Henceforth, and similar to Etro and Caffarra (2017), the timing of the game is as follows:

1. Google ties if allowed, or tying is prohibited;
2. Each firm owning a search engine offers a bid for each mobile device sold;
3. OEMs accept an offer and assemble the four components of the smartphone: hardware, OS, SE and apps;
4. OEMs set prices for their devices;
5. Users buy the device that maximizes their utility.

Each remedy will impose small adjustments in the timing of the game that will be explained in their respective sections.

III.A *Status Quo*

The first scenario I present is the situation where Google ties its search engine to the suite (MADA) and OEMs have to choose between producing a normal and a forked Android (AFA). The theory of harm is based on the possible exclusion of a search engine that would win the market if there were no market failures. Therefore, I assume the existence of an Entrant which is more valued than Google as in Etro and Caffarra (2017) formulation, i.e. $v_E - v_G = \Delta > 0$. In this first scenario, users have two possible outcomes in terms of utility:

$$U_A = v_E - P_E, \tag{1}$$

$$U_D = v_G + \kappa + x - P_G. \tag{2}$$

Equations (1) and (2) give the utility for each element of the homogeneous group of users if the smartphone assembled corresponds to case (A) and (D), respectively. Presented with a smartphone with the Entrant SE, the users derive a utility of v_E due to the search engine minus the

price paid for the smartphone, P_E . Recall this device is a fork with no suite. On the other hand, a user with Google Search and the Suite has a valuation of v_G and x for each of those components, respectively, minus the device's price, P_G . Additionally, there is a utility gain of κ given by the complementarity effect, i.e. the increase in user experience in the search engine when used alongside the Google Suite apps.

Users buy smartphone (D) if the resulting utility is higher than the one given by the fork (A). Equation (3) presents the relationship prices need to obey, so that utility of buying (D) is higher:

$$P_G \leq P_E - \Delta + \kappa + x. \quad (3)$$

There are multiple OEMs in this market that compete in prices. In market equilibrium, the price they charge is given by the constant marginal cost of producing the smartphone, which is assumed to be the cost of hardware, c , and the pre-installation bid received from the search engine, b_i , which can represent a cost reduction ($b_i > 0$) or a cost increase ($b_i < 0$):

$$P_i = c - b_i, \quad i = G, E. \quad (4)$$

Choosing the option that gives the highest utility makes OEMs to undercut rivals that choose hypothesis that provide lower utility to consumers. Due to perfect competition in the OEMs market, all the players will do the same and their profits equal zero. Considering equation (3) and (4) what determines the highest utility for users is the bid. The condition that gives Google the winning bid is:

$$b_G \geq b_E + \Delta - \kappa - x. \quad (5)$$

Before I assess the decision of the search engines, I will describe their profit function. Search engines receive an advertising revenue per user of β (assumed equal to the gain of the advertisers).

In order to be preinstalled in a device, firms must pay to the OEM through a bid. Additionally, Google receives an amount α per user from in-app advertising gains that the suite provides. In the *status quo*, Equation (6) gives Google's profits per consumer and equation (7) the Entrant's.

$$\pi_G = \alpha + \beta - b_G, \quad (6)$$

$$\pi_E = \beta - b_E. \quad (7)$$

The SE that loses the bidding process does not receive β and it does not pay the bid. Google outbids the Entrant at the minimum bid that still makes consumers choose the smartphone with Google Search and the suite. Considering equation (5), Google can outbid the Entrant with $b_G = \beta + \Delta - \kappa - x$, since β is the maximum value the Entrant is able to bid. Smartphone (D) is in the market at the price:

$$P_G = c - \beta - \Delta + \kappa + x. \quad (8)$$

The Entrant stays out of the market and Google makes a positive profit as long as $\Delta < x + \kappa + \alpha$:

$$\pi_G = \alpha - \Delta + \kappa + x. \quad (9)$$

The resulting users utility, i.e. consumer surplus, is:

$$CS = U_D = v_G + \beta + \Delta - c \quad (10)$$

$$= v_E + \beta - c. \quad (11)$$

Finally, the total surplus corresponds to the sum of the utility of users and profits:

$$TS = v_G + \beta + \kappa + x + \alpha - c. \quad (12)$$

The market equilibrium in the *Status quo* is the existence of a smartphone with Google Search and Google Suite. This outcome is valid under the condition that $\Delta < \alpha + \kappa + x$. The complementarity effect, under tying, can be weak as long as the sum of the suite valuation, x plus in-app advertising revenues, α , are at least as high as the differences in valuations between the two search engines, i.e. $\Delta \leq \alpha + x$.

Proposition 1. *Smartphone (D) is offered under a scenario where tying is in place if the condition $\Delta < \alpha + \kappa + x$ is verified.*

The *status quo* equilibrium falls below the social optimum if $\Delta > \kappa$. If any combination of a search engine with suite and no suite was allowed, the option that delivered higher total surplus would have a smartphone with the Entrant SE and the suite if $\Delta > \kappa$ or Google and the suite if $\Delta < \kappa$. Figure 2 presents the total surplus each option would generate.

	Suite	No suite
Google	$v_G + \kappa + x - c + \alpha + \beta$	$v_G - c + \beta$
Entrant	$v_G + \Delta + x - c + \alpha + \beta$	$v_G + \Delta - c + \beta$

FIGURE 1: Total surplus generated if each smartphone was sold in the market

Proposition 2. *The tying of Google Search is only harmful to society if integration does not compensate the users' higher valuation of the Entrant:*

1. *If $\Delta > \alpha + \kappa + x$, tying decreases total surplus because smartphone (A) is sold in the market. The Entrant with the suite (B) is the socially optimal smartphone. There is a market failure: the Entrant wins but without the suite;*

2. If $\kappa < \Delta < \alpha + \kappa + x$, tying decreases total surplus because smartphone (D) is sold in the market. The Entrant with the suite (B) is the socially optimal smartphone. There is a market failure: Google wins when the Entrant should;
3. If $\Delta < \kappa$, Google wins the bid with the suite installed in the smartphone and it is socially optimal.

$\Delta > \kappa$ is necessary for the Entrant to be socially optimal and the decrease in total surplus is equal to $\Delta - \kappa$ if $\Delta < \alpha + \kappa + x$, and $\alpha + x$ otherwise.

III.B Market Outcome without tying

Tying eliminates two options: a smartphone with Google Search and no suite (C) and a smartphone with the Entrant and suite (B). The first one is automatically ruled out since an OEM would never consider an inferior product, unless the suite is overly priced. In the current section, the suite is free of charge, so a smartphone with Google Search and no suite will never be optimal. Overall, under no restrictions, four smartphones are possible and figure 2 presents the utilities they give to consumers.

	Suite	No suite
Google	$U'_D = v_G + \kappa + x - P'_G$	$U'_C = v_G - P'_G$
Entrant	$U'_B = v_E + x - P'_E$	$U'_A = v_E - P'_E$

FIGURE 2: User's utility for each smartphone assembled by an OEM

OEMs compete *à la* Bertrand. Thus, OEMs offer the combination that gives the highest surplus for the user. Given perfect competition in the smartphone market and absence of profits to

OEMs, the winning search engine makes profits corresponding to the difference between the highest surplus alternative and the second best. I will demonstrate this mechanism.

Combination "Google + no suite" (C) is dominated by (D), and smartphone (A) is dominated by (B) in the absence of a license fee for the suite. It comes to the point of choosing Google Search or the Entrant in a smartphone with the suite. Equation (13) presents the pricing rule that makes smartphone (D) to create the highest surplus.

$$P'_G \leq P'_E - \Delta + \kappa. \quad (13)$$

As demonstrated in the previous section, the price of the smartphone equals the marginal cost which depends on the SE bid. Considering equation (4) and (13) the condition that determines Google's bid wins and gives the highest surplus is:

$$b'_G \geq b'_E + \Delta - \kappa. \quad (14)$$

Now we are comparing options (D) and (B), meaning the suite will be installed whether Google Search or the Entrant is pre-installed. Thus, Google has the revenue α in both cases. In the scenarios without tying, α does not affect who wins and Google will not use α to increase its maximum bid as in the tying scenario since it would lead to a lower profit than losing the bidding. The profit functions remain the same as in equations (6) and (7), however, if the Entrant SE wins the bidding process, Google will still make a profit equal to α .

If $\Delta > \kappa$, from now on denominated **condition 1**, equation (14) cannot be verified as Google's bid that maximizes profits need to be at most equal to the advertising gain, β . Otherwise, if $b'_G \in]\beta; \beta + \alpha]$ Google's profits would be below α , the profit of losing the bid. Henceforth, option (B) creates the highest surplus and the Entrant can outbid Google with:

$$U'_B > U'_D \Leftrightarrow P'_E < P'_G + \Delta - \kappa \quad (15)$$

$$\Leftrightarrow b'_E > b'_G - \Delta + \kappa. \quad (16)$$

In the limit, the minimum winning bid of the Entrant is given by:

$$b'_E = \beta - \Delta + \kappa. \quad (17)$$

Hence, the Entrant makes profits equal to the difference in surplus between options, i.e. $\pi'_E = \Delta - \kappa$. Google makes a profit $\pi'_G = \alpha$.

If $\Delta < \kappa$, named **condition 2** hereafter, option (D) creates the highest surplus. Equation (14) is verified and Google outbids the Entrant with a bid:

$$b'_G = \beta + \Delta - \kappa. \quad (18)$$

Google makes profits equal to the difference of utilities plus revenues from in-app advertising, i.e. $\pi'_G = \alpha - \Delta + \kappa$. The set of surpluses, prices and bids of **conditions 1 and 2** are presented in table 1 at the end of the presentation of all scenarios.

Proposition 3. *According to the model, the tie allowed Google to have a higher profit under both conditions. If $\Delta > \kappa$, **condition 1**, $\pi_G - \pi'_G = x - \Delta + \kappa$ was the additional revenues the tie enabled Google to receive for Android's maintenance. Under **condition 2**, $\pi_G - \pi'_G = x$.*

III.C Remedy 1: suite license fee

The following two sections provide descriptions and analyses of the adoption of specific remedies after the prohibition of tying. The aim is to improve the *status quo*. The results provide arguments for the negotiations between Google and the European Commission while they negotiate the end of the tie. In reality, I expect the remedy to impose the optimum total surplus, but with a mechanism to compensate Google and enable the firm to continue to preserve and improve the Android environment.

First, I will model the announced solution Google offered: a license fee for the suite. Google now chooses a license fee in response to the prohibition of tying. Proposition 3 states the amount Google loses with the prohibition of tying. Henceforth, I will look at the four types of devices discussed in the previous section, but allowing Google to charge a license fee.

Now Google chooses l at the beginning of the game after tying is not allowed and all the other interactions remain the same:

1. Tying is prohibited;
2. Google sets the license fee for the app suite;
3. Google and the Entrant offer a bid for each mobile device sold;
4. OEMs accept an offer and assemble the four components of the smartphone: hardware, OS, SE and apps;
5. OEMs set prices for their devices;
6. Users buy the device that maximizes their utility.

Once again, I solve the game by backward induction. Given l , OEMs assemble the smartphone that creates the highest surplus for users. We repeat the Bertrand game of the previous section where search engines make a profit corresponding to the difference between utilities.

Hence, I will vary l to find the device offered and then have search engines compete for pre-installation. Bids b_i cannot depend on whether smartphones have the suite or not, since the decision by the OEMs on each component is simultaneous. In this scenario, the price of a smartphone with the suite is higher than the price with no suite, because Google increases OEMs' marginal cost by l , the license fee, i.e. $\hat{P}_i'' - P_i'' = l$, $i = G, E$. Equation (19) gives the price of the smartphones with the suite under perfect competition between OEMs:

$$\hat{P}_i'' = c - b_i + l, \quad i = G, E. \quad (19)$$

Figure 3 summarizes users' utilities taking into account the license fee:

	Suite	No suite
Google	$U_D'' = v_G + \kappa + x - P_G'' - l$	$U_C'' = v_G - P_G''$
Entrant	$U_B'' = v_E + x - P_E'' - l$	$U_A'' = v_E - P_E''$

FIGURE 3: Users' utility for each smartphone assembled by an OEM considering when Google sets a license fee

I will look at two different conditions. In **condition 1**, $\Delta > \kappa$. Afterward, **condition 2** will consider pricing in a scenario where complementarity is a more salient characteristic than differences between search engines, $\Delta < \kappa$.

Starting with **condition 1**, i.e. $\kappa < \Delta$, analyzing the possible values of l simplifies the rest of the process. For a license fee, l , below $x + \kappa$ option (D) dominates (C). For a license fee higher than the suite valuation, $l > x$, smartphone (A) dominates (B). On the contrary, if $l \leq x$, OEMs prefer to offer the Entrant with the suite over the Entrant without the suite. Hence, if $l \in]x, x + \kappa]$ it is relevant to compare option (D) and (A) to see the optimal value of license fee and the bid for each firm. If $l \in]0, x]$, option (D) is compared to (B).

Returning to backward induction, in the former scenario in which competition occurs between the choice of smartphones (D) and (A), i.e. $l \in]x, x + \kappa]$, l plays a role defining the highest surplus between the two. Equation (21) below presents the relationship.

$$U_D'' \geq U_A'' \Leftrightarrow \hat{P}_G'' \leq P_E'' - \Delta + \kappa + x \quad (20)$$

$$\Leftrightarrow b_G'' \geq b_E'' + \Delta - \kappa - x + l. \quad (21)$$

Bear in mind that each SE will bid until its limit, β , otherwise they will be out of the market. Thus, the SE outbids the other by bidding an amount the other cannot equal. An SE that wins makes $\beta - b_i''$ of profits or has zero profits. Apart from that, Google has an additional revenue stream corresponding to α which is lost under option (A). Note that l corresponds to an internal transfer and it does not directly increase Google's profits, i.e. any positive amount of l implies a higher bid (higher cost), b_G'' . However, it can make Google to win the bidding process. Equation (21) above would only be possible if:

$$l \leq x + \kappa - \Delta. \quad (22)$$

Condition 22 falls outside the interval $l \in]x; x + \kappa]$ if $\Delta > \kappa$.

Now, If (D) was to compete with (B), i.e. $l \in]0, x]$, option (B) would be offered under **condition 1**. Equation (24) shows this finding since it is impossible for b_G to have a value above β as imposed by the equation. Henceforth, the utility of option (D) can never be higher than (B) in the domain of l considered. Recall that, when comparing (D) to (B), α does not affect who wins.

$$U_D'' \geq U_B'' \Leftrightarrow \hat{P}_G'' \leq \hat{P}_E'' - \Delta + \kappa \quad (23)$$

$$\Leftrightarrow b_G'' \geq b_E'' + \Delta - \kappa. \quad (24)$$

For any value of $\Delta > \kappa$, $l = x$ is profit maximizing for Google with $\pi_G'' = \alpha + x$ since profits are higher than zero. The Entrant SE is pre-installed with a bid, in the limit, equal to $b_E'' = \beta - \Delta + \kappa$ and its profits $\pi_E'' = \Delta - \kappa$:

$$U_A'' > U_D'' \Leftrightarrow P_E'' < \hat{P}_G'' + \Delta - \kappa - x \quad (25)$$

$$\Leftrightarrow b_E'' > b_G'' - \Delta + \kappa + x - l. \quad (26)$$

Finally, l is never above $x + \kappa$ as Google will never be able to outbid the Entrant and it makes zero profits under **condition 1**, $\Delta > \kappa$:

$$U_C'' \geq U_A'' \Leftrightarrow P_G'' \leq P_E'' - \Delta \quad (27)$$

$$\Leftrightarrow b_G'' \geq b_E'' + \Delta. \quad (28)$$

Proposition 4. *At $\Delta > \kappa$, the license fee cannot exclude the Entrant SE and Google charges x for the suite. The smartphone sold in the market corresponds to option (B).*

At $\Delta > \kappa$, Google is overcompensated with a license fee of x . Proposition 3 states that under the tie Google was receiving an additional amount of $x - \Delta + \kappa$ which is lower than x .

Condition 2, $\Delta < \kappa$, maintains (C) has dominated and the possible values of l between zero and $x + \kappa$. However, equation (21) is now verified, because condition 22 is now inside the domain $l \in]x; x + \kappa]$. Smartphone (D) is chosen for a combination of values l and b_G'' that always give Google a profit of $\pi_G'' = \alpha + x + \kappa - \Delta$. Hence, $l \in]x; x + \kappa - \Delta]$ and $b_G'' \in]\beta + \Delta - \kappa; \beta]$. Again, Google has no incentive to set l above $x + \kappa$ as it delivers zero profits as demonstrated previously.

Taking into account the other possible values of l , i.e. $l \in]0; x]$, equation (24) encloses a bid

$b''_G = \beta + \Delta - \kappa$. Google has incentives to choose a license fee equal to x and $b''_G = \beta + \Delta - \kappa$. This decision delivers the same profit as the equilibrium where l can take values above x .

There are infinite equilibria in which Google sets a license fee between x and $x + \kappa - \Delta$. So, Google can decide on a value of l such that $l \in [x; x + \kappa - \Delta]$ and adjusts the bid according to $b''_G = \beta + \Delta - \kappa - x + l$, so that device (D) is always preferred and the firm's profits are maximized. The set of surpluses, prices and bids of **conditions 1 and 2** are presented in table 1 at the end of the presentation of all scenarios.

Proposition 5. *At $\Delta < \kappa$, Google has an infinite number of combinations between the amount of the license fee and the bid to have its search engine and the suite in the smartphone sold to the market. In equilibrium Google makes profits equal to $\alpha + x + \kappa - \Delta$ choosing $l \in [x; x + \kappa - \Delta]$ and adjusting the bid according to $b''_G = \beta + \Delta - \kappa - x + l$. Depending on the value of l , b''_G can take values within the interval $[\beta + \Delta - \kappa; \beta]$.*

At $\Delta < \kappa$, Google is compensated by the same amount of the tie, i.e. x . The difference between the profits of no-tying with and without the license fee $\pi''_G - \pi'_G = x$ is equal to the one in proposition 3.

III.D Remedy 2: suite license fee and no pre-installation of the SE

As I demonstrated previously, there is the possibility that Google keeps competitors away taking advantage of the complementarity between its services. This strategy guarantees Google dominance under the condition that $\Delta < \kappa$ for an interval of values for the license fee and the bid. Alternatively, I propose a second remedy that would shift the decision for the search engine from the OEMs to the users.

Remedy 2 forfeits pre-installation and enables people to choose the search engine in the first time they switch on the smartphone. It is a realistic scenario since all smartphones have already an initial setup process. Users choose the SE they want at the beginning of usage and then it is fully integrated with the smartphone features. Hence, in our model choosing the SE in the initial setup is the same as consistently using the same SE to give results on the address bar input.

Once again, the timing of the game changes:

1. Tying is prohibited;
2. Google sets the license fee for the app suite;
3. OEMs assemble three components of the smartphone: hardware, OS and apps. All smartphones come with the option of installing any search engine upon the initial setup;
4. OEMs set prices for their devices;
5. Users decide if they buy the device and choose the search engine that maximizes their utility.

Following the same rational of the previous sections, the highest surplus wins, then the suite is pre-installed in the smartphone. In the initial setup, users will choose the Entrant if $\Delta > \kappa$ and Google Search if $\Delta < \kappa$ as long as the suite is not overpriced. The price will only reflect the existence of the suite, so Google chooses the maximum price that makes the suite to be in the smartphone.

Under **condition 1**, smartphones with the Entrant SE and the suite are sold at price equal to $\hat{P}_E''' = c + x$ and Google sets a license fee of x . Under **condition 2**, smartphones with the Google Search and the suite are sold at price equal to $\hat{P}_G''' = c + x + \kappa - \Delta$ and Google sets a license fee of $x + \kappa - \Delta$.

Elaborating on remedy 2, I will assume now users will multi-home. Independently from the price of the smartphone, users will choose the search engine more suitable for the query. $\phi(G) \in$

$[0, 1]$ is the probability of Google Search being chosen over the Entrant. $1 - \phi(G)$ is the users' probability of using the Entrant SE.

The multi-homing outcome becomes a weighted average between **conditions 1 and 2** above. The weight is the value of $\phi(G)$.

Proposition 6. *Ruling out pre-installation increases the prices of smartphone compared to the status quo and remedy 1. It is the scenario that hurts users more. If $\Delta > \kappa$, smartphone (B) is sold at $\hat{P}_E'' = c + x$. If $\Delta < \kappa$, smartphone (D) costs users $\hat{P}_G'' = c + x + \kappa - \Delta$, the highest possible price in the market.*

Table 1 summarizes the surpluses, prices and the license fee in all the scenarios analyzed.

	Status Quo	III.B	III.B	III.C	III.C	III.D	III.D
		Condition 1	Condition 2	Condition 1	Condition 2	Condition 1	Condition 2
CS	$v_G + \beta + \Delta - c$	$v_G + \beta + \kappa + x - c$	$v_G + \beta + \Delta + x - c$	$v_G + \beta + \kappa - c$	$v_G + \beta + \Delta - c$	$v_G + \Delta - c$	$v_G + \Delta - c$
π_G	$\alpha - \Delta + \kappa + x$	α	$\alpha - \Delta + \kappa$	$\alpha + x$	$\alpha - \Delta + \kappa + x$	$\alpha + x$	$\alpha + \beta + \kappa + x$
π_E	0	$\Delta - \kappa$	0	$\Delta - \kappa$	0	β	0
TS	$v_G + \beta + \kappa + x + \alpha - c$	$v_G + \beta + \Delta + x + \alpha - c$	$v_G + \beta + \kappa + x + \alpha - c$	$v_G + \beta + \Delta + x + \alpha - c$	$v_G + \beta + \kappa + x + \alpha - c$	$v_G + \beta + \Delta + x + \alpha - c$	$v_G + \beta + \Delta + x + \alpha - c$
P_i	$c - \beta - \Delta + \kappa + x$	$c - \beta + \Delta - \kappa$	$c - \beta - \Delta + \kappa$	$c - \beta + \Delta - \kappa$	$c - b_G, b_G \in [\beta + \Delta - \kappa; \beta]^*$	c	c
l	-	-	-	x	$[x; x + \kappa - \Delta]^*$	x	$x + \kappa - \Delta$

TABLE 1: Summary of surpluses, prices and license fees for each scenario. Note that total price is $P_i + l$ when l is exists. *The choice of P and l is constrained $b_G'' = \beta + \Delta - \kappa - x + l$.

IV Conclusions

The model presented in this paper aims at providing a rationale on why it is important to consider complementarity in services by Google in the general internet search services market. The model shows that, if complementarity between Google Search and the suite is strong enough in the smartphone market, the outcome of the tie does not change after the prohibition of tying. In

fact, smartphone (D) is the socially optimal choice and prices are the same under both scenarios. Henceforth, in this case, the tying is irrelevant and market outcomes do not change. Surpluses are also the same. The European Commission should not fear to break the tie and allow a license fee for the Google Suite. Smartphone prices will remain the same in equilibrium as the bid of search engines adjusts.

If the valuation difference between search engines is higher than the complementarity effect, then the total surplus is the highest after disallowing tying and users' surplus decreases. Prices are higher, not because users are paying the suite afterward, but the pressure of Google on increasing the rival's bid (κ) is lower than the Entrant's pressure (Δ) under tying.

Furthermore, under the argument that rents Google extracted from the tying were necessary to allow the maintenance of Android Eco-system, they should not represent more than the difference in profits between scenarios in section III.A and III.B. Under **condition 1**, Google will be more-than-compensated with a license fee of x . Considering **condition 2**, the tying is irrelevant and after its prohibition, the market outcome and surplus is the same. It is relevant to point out that the license fee is not capable of foreclosing the Entrant after the prohibition of tying. The bidding mechanism is necessary to ensure these results. When multi-homing occurs, users become worse compared to the situation they are charged with a license fee.

In a period of tough negotiations between the European Commission and the tech giants, some light is cast to the fact that the Android case decision may be less risky in terms of future outcomes than the news and previous research indicated. The suspicion that prices may get higher because of the suite's license fee lacks theoretical evidence when bids for pre-installation exist, which is a more realistic scenario at the moment. Afterward, Google has the incentive to allow multi-homing in the search bar of smartphones. The European Commission should keep a close look to prevent this move.

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